

RELATIONSHIP BETWEEN INDIVIDUAL PERSONALITY VARIABLES  
AND BODY TEMPERATURE RESPONSE PATTERNS IN THE COLDBERNARD J. FINE AND HENRY F. GAYDOS<sup>1</sup>*Psychology Branch, Quartermaster Research and Engineering Center, US Army,  
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While there is some evidence to indicate that strong and complex relationships exist between the psychological and physiological responses of human beings to stress-provoking stimuli (1, 6, 11, 12, 15, 18), much of this evidence is anecdotal or has been obtained using very small numbers of Ss. The present study was designed to provide additional information about, and substantiation of, the apparent relationships between certain psychological and physiological factors under stress, based on a large enough sample of Ss to permit adequate statistical treatment of the data. The study departs from conventional stress techniques in that it employs exposure to extreme temperature, in this case, cold, as the stress-provoking stimulus.

From a qualitative analysis of some unpublished data concerning rectal temperature measurements in the cold,<sup>2</sup> it is apparent that the differences between individual rates of *recovery* of "normal" rectal temperatures after removal from cold stress conditions are greater than the differences between individual rectal temperatures *prior to* and *during* exposure to cold and that some of this variation can be accounted for by psychological factors, particularly the variability of the personality attributes of Ss. Most research involving rectal temperatures has focussed on pre-exposure and exposure periods (2, 5, 14, 17).

The emphasis on the post-exposure measures of body temperature is based on the assumption that individuals, during exposure to a very stressful stimulus, differ less in their physiological responses to it than in their abilities to recover from it. In severe stress, the stimulus is apparently of sufficient magnitude to over-ride any individual differences in physiological response. Thus, for example, men placed nude in an ambient temperature of 30°F would show about the same patterns of skin cooling and internal body temperature change. Removal from exposure to the stressful stimulus should then allow individual differences in physiological structure and function to manifest themselves in different rates of recovery of thermal equilibrium. Therefore, recovery from exposure to stress appears to provide, at least on a logical basis, a better opportunity for study of the relationship of psychological variables with physiological

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<sup>2</sup>The unpublished data has been obtained from a number of studies in cold stress conducted over a two-year period at the Quartermaster Research and Engineering Center, Natick, Massachusetts.

reactions to stress. Studies by Henschel, Brozek, and Keys (13) and Eysenck (9) appear to point to the value of studying post-stress responses.

The study was designed specifically to investigate the apparent relationships between rectal temperature recovery rate after exposure to the cold and Ss' personality attributes. Measurements of feelings of coldness and of body weight, height, and fat content were included to provide additional control and information.

#### METHOD

##### Subjects

Ss were 70 enlisted men from Fort Devens, Massachusetts. They were part of a larger group brought to the Quartermaster Research and Engineering Center daily in groups of 12 to participate in experiments conducted during the period 3 to 20 March, 1958.

##### Tests and Measurements<sup>3</sup>

*Rectal temperature.*—Thermistor catheters and a portable galvanometer were used to measure rectal temperatures according to the procedure described by Breckenridge (3). Readings were taken every 10 min. during the pre-exposure and exposure periods, and every 5 min. during the post-exposure period.

*Subjective feelings of cold.*—Ss indicated how cold they felt by pressing one of six buttons labelled "warm," "cool," "cold," "very cold," "extremely cold," and "freezing" at 5-min. intervals during the exposure period. The choices were recorded by experimenter.

*Morphological measurements.*—All Ss were weighed and measured for height. Percent of body fat was computed from measurements taken by the skin fold technique according to the procedure described by Brozek and Keys (4).<sup>4</sup>

*Personality measures.*—The Minnesota Multiphasic Personality Inventory (MMPI) was administered to all Ss. The basic responses thus obtained were treated in a manner presented by Welsh (19) to derive two measures of personality described as the Anxiety Index (AI) and the Internalization Ratio (IR). These measures appear to have greater clinical validity in detecting deviations from the "normal" than the separate scales of the MMPI as they have been customarily used in experimental research.

The Anxiety Index is derived using the formula,

<sup>3</sup>A table of raw scores for all tests and measurements made has been placed on file and may be obtained by ordering Document No. 5831, remitting \$1.25 for 35 mm. microfilm or \$1.25 for photocopies from ADI Auxiliary Publications Project, Photoduplication Service, Library of Congress, Washington 25, D. C.

<sup>4</sup>The authors wish to thank Dr. T. McKern for obtaining these measurements and Miss Ella Munro for computing certain of the indices.

$$AI = [(Hs + D + Hy)/3] + [(D + Pt) - (Hs + Hy)]$$

where *Hy*, *D*, *Hs*, and *Pt* refer, respectively, to the Hysteria, Depression, Hypochondriasis, and Psychasthenia scales of the MMPI. The index is defined so as to yield a theoretical value of 50 for a "normal" score. Deviations from a score of 50 appear to have valid clinical meaning both as to amount and direction. Although Welsh (19) cites only examples of deviations above 50 as being indicative of personality disturbance, for the purposes of this study, both extremely high and low AI scores are considered to be indicative. Several studies indicate that deviation in both directions should be considered in using personality tests (7, 8, 10, 16).

The Internalization Ratio is expressed by:

$$IR = (Hs + D + Pt) / (Hy + Pd + Ma),$$

where *Hs*, *D*, *Pt*, *Hy*, *Pd*, and *Ma* represent the Hypochondriasis, Depression, Psychasthenia, Hysteria, Psychopathic Deviate, and Hypomania scales of the MMPI, in that order. The IR is defined so that it yields a theoretical value of 1.00 in "normal" cases. Individuals who tend to "internalize" their problems, who experience somatic symptoms and subjective feelings of stress, would be expected to obtain IR scores above 1.00. Those individuals who "externalize" their conflicts would be expected to score below 1.00.

##### Experimental Procedure

Upon arrival at the laboratory, Ss were briefed on the studies in which they were to participate, were assured that the studies were in no way dangerous, and were given a physical examination. They also completed a biographical questionnaire and took some tests relevant to another study which is not reported here.

Ss then proceeded to the Climatic Chamber dressing room where they were given specific instructions regarding the nature of the study and what they were expected to do. After stripping to their shorts, Ss were weighed, measured for height and body fat content, equipped with a rectal temperature-sensing device and were placed in reclining wheel chairs.

Ss remained lying in the wheel chairs for 30 min. at a room temperature of 70°F, 50% relative humidity, in order to obtain control measurements. Rectal temperatures were recorded every 10 min. during this period. Three readings were taken, the final one just prior to the end of the period. During the pre-exposure period, Ss were not allowed to leave their chairs, smoke, read, or move unnecessarily.

At the conclusion of the 30-min. pre-exposure period, Ss were wheeled into the controlled temperature room where the conditions were maintained at 50°F, 50% relative humidity, and 5 mph wind speed. Ss remained

in the room, lying practically motionless, for 75 min. During this time, rectal temperatures and subjective sensations were recorded.

Ss were then returned to the dressing room, the temperature of which was now 78°F (to facilitate rewarming). Rectal temperatures were recorded during the entire 115-min. post-exposure period.

After the post-exposure period, Ss were given a good meal and relaxed for a short while. They then completed the MMPI.

#### RESULTS

On the assumption that extreme scores in either direction on the personality scales discussed above would be indicative of personality deviation, Ss were ranked in order of their scores on both the AI and the IR. These two sets of rankings were then each divided into approximate thirds, and Ss scoring in the upper thirds of *both* scales, and in the lower thirds of *both* scales were designated as "deviant."<sup>5</sup> Of the total number of 70 Ss, 10 were not able to complete the MMPI (perhaps, due to being slow readers), 28 fell into the "deviant" category, and the remaining 32 constituted the "normal" group.

The physiological variable to be compared with the personality measures was taken as the time required to regain rectal temperature equilibrium.<sup>6</sup> When men enter normal ambient temperatures after having been exposed to the cold for some length of time, rectal temperatures characteristically drop as the blood circulates through the cold periphery of the body, is cooled, and returns to the core. It is the individual variability in the rises following these drops in temperature that is of interest here. The point in time, during the post-exposure period, at which S's rectal temperature reached its lowest point and then showed consistent rise was arbitrarily selected as the criterion of recovery from cold exposure. Consistent rise was operationally defined as a reading of at least 10 min. duration which was at least 0.2°F above the lowest post-exposure reading of that S.

TABLE 1  
COMPARISON OF "DEVIA" AND "NORMAL" GROUPS IN NUMBER OF SUBJECTS  
SHOWING CONSISTENT RISE IN RECTAL TEMPERATURE WITHIN  
115-MINUTE TIME LIMIT

	"Deviant" Group	"Normal" Group
N showing consistent rise	6	23
N not showing consistent rise	19	9
Total N*	25	32
$\chi^2 = 12.87$ , with 1 <i>df</i>		
$p < .01$		

\*Total N is less than 70 because 10 Ss were not able to complete the MMPI in the allotted time, and 3 had faulty rectal catheters.

<sup>5</sup>There were, of course, theoretically two other extreme groups, i.e., upper-third AI and lower-third IR and vice-versa. However, only one S fell into this "mixed" category.

<sup>6</sup>Designated as TRTR, "Time to rectal temperature rise."

The comparison of the "deviant" group and the "normal" group with respect to the number of Ss in each having a TRTR of less than 115 min. (the total recovery time allowable in the study) is shown in Table 1.

A significantly larger number of Ss in the "normal" group than in the "deviant" group showed consistent rise in rectal temperature following cold exposure. When the two groups are classified *only* on the basis of the AI or *only* on the basis of the IR, no differences between the groups in numbers of Ss having a TRTR of less than 115 min. were found. This indicates that the AI and IR combination is contributing to the obtained significant difference. For classification purposes, it is apparently not enough to know that a given personality is deviant in terms of the presence or absence of anxiety symptoms. The additional information as to how the person handles that anxiety is needed.

A more desirable analysis of the data would have been a comparison of the two groups in actual times taken for rectal temperature recovery. Unfortunately, due to the time limit imposed on the study and the resultant 115-min. recovery period, the distributions of recovery times were skewed so that appropriate statistics for comparison of actual times could not be used. Therefore, no statistical statement can be made regarding the obtained mean differences in recovery times between the "deviant" group (108.00 min.) and the "normal" group (96.56 min.).

No significant differences (*t*-test) were found between the rectal temperatures of the "deviant" and "normal" groups either before or during exposure. Similarly, no significant differences were found between the "deviant" and "normal" groups with regard to the morphological measurements.

TABLE 2  
COMPARISON OF SUBJECTIVE FEELINGS OF COLD BETWEEN  
GROUPS DIFFERING IN MORPHOLOGY

	Body-Surface-Area*		Fat-Free Weight*	
	Lower Quartile	Upper Quartile	Lower Quartile	Upper Quartile
Mean subjective score**	4.84	3.66	4.61	3.65
N	16	16	18	17
<i>t</i> (two tails)	3.50		3.03	
<i>p</i>	< .01		< .01	

\*Body-Surface-Area and Fat-Free Weight are intercorrelated (Pearson product-moment correlation) significantly ( $r = .96$ ).

\*\*Lower mean subjective score indicates greater feeling of warmth.

With regard to subjective responses to cold, significant differences were obtained between groups differing in morphological characteristics. These results are shown in Table 2. The morphological groups represent the upper and lower quartiles of the distribution of the respective morphological measure-

ments. No relationships were found between rectal temperature change in the cold and any of the morphological measurements.

From these data it can be concluded that larger men (larger in terms of Body Surface Area and/or Fat-Free Weight) feel warmer in a given ambient temperature than do smaller men. No relationship was found between feelings of warmth and Percent Body Fat, indicating that the popular belief that fat people feel warmer than thin people is questionable.

#### DISCUSSION

It is difficult to account for the obtained relationship between the psychological and physiological variables. A reasonable explanation derives from a study by Henschel, Brozek, and Keys (13) which indicated that, after cooling, schizophrenic Ss as compared with normal Ss took longer to show reflex vasodilation following immersion of feet and lower legs in warm water. Henschel, *et al.* hypothesize that these differences were due either to an exceptionally high state of tonus in the skin vessels or to an abnormally high temperature threshold in the hypothalamus of the schizophrenic.

Since the rate of recovery of rectal temperature equilibrium after exposure to the cold is highly dependent upon the rate of rewarming of the extremities, the hypothesis advanced by Henschel, *et al.* is applicable here. If it can be assumed that there are structural or functional differences in the sympathetic or autonomic systems between normal and non-normal individuals, and that the psychological test employed in this study is validly discriminating between normal and "less normal" individuals, then these differences might be expected to manifest themselves in the temperatures of the extremities of the present Ss.

Thus, in the present study, the "deviant" Ss, when removed from the cold, would be expected, following the results of the Henschel, *et al.* study, to remain vasoconstricted in the extremities for a longer period of time than the "normal" Ss. With vasoconstriction of the extremities, it follows that the body core will tend to resist the characteristic drop in temperature prior to rewarming since it is less subject to the cooling influence of the extremities. The "normal" Ss, however, should show a more rapid vasodilation of the extremities and, hence, a more rapid circulation of the blood through the extremities. This should result in faster cooling down of the body core and, ultimately, in faster rewarming.

The value of focussing on measurements during recovery from stress is borne out by the data. Virtually no significant differences were found between the two groups for measures taken before or during exposure whereas significant differences were found for measurements taken during recovery.

Finally, it should be emphasized that the term "deviant" used in reference to one of the groups differentiated by the personality inventory does not

necessarily imply a pathological state. Ss were selected as being deviant on the basis of their scores in relation to the group as a whole. When compared with other groups, both normal and clinical, only a very few individuals had scores which came well within the range of the clinical group.

#### SUMMARY

70 Ss were exposed nude to successive climatic conditions of 70°F, 50°F, and 78°F for periods of 30, 75, and 115 min., respectively. Rectal temperatures, morphological measurements, ratings of subjective feelings of cold and personality measurements (MMPI) were obtained. Ss, whose combined scores on the MMPI-derived Anxiety Index and Internalization Ratio deviated widely from the group norm, took significantly longer than less deviant Ss to show a rise in rectal temperature following exposure to cold. Heavy, large men felt warmer than light, small men during exposure to the same cold condition. The meaning of the data is discussed.

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